

# PATENT ABSTRACTS OF JAPAN

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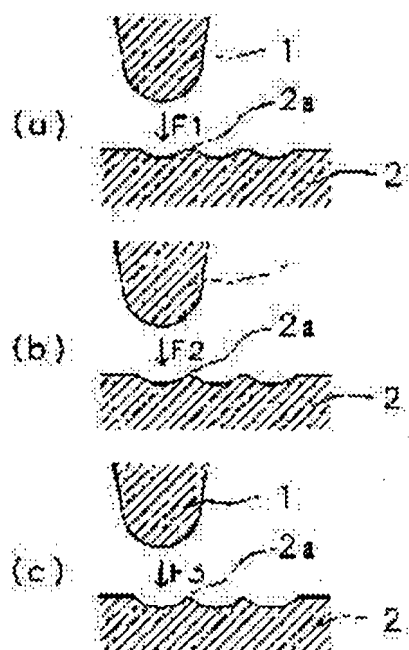
(54) MANUFACTURE OF MOLD, AND OPTICAL ELEMENT MANUFACTURED THEREBY

(57)Abstract:

$F1 < F2 < F3$

**PROBLEM TO BE SOLVED:** To form a dent having desired shape by pressing an indenter on the mold matrix surface over several times on the same position during formation of the dent.

**SOLUTION:** The surface of a mold matrix (cavity surface) comprising a martensitic stainless steel is subject to a metal polishing process so as to form the cavity surface of the mold matrix in the mirror surface. Firstly, an indenter 1 is pressed on the cavity surface at a pressing force  $F1$ . After the dent is formed on the full surface of the cavity surface at the pressing force  $F1$ , the indenter 1 is then pressed on the formed dent at the pressing force  $F2$  larger than  $F1$ . Further, the indenter 1 is pressed on the formed dent at the force larger than the pressing force  $F2$ . The pressing force is gradually increased and pressed over several times, which controls the lateral shift of materials 2a which are the adjacent boundaries of the bent of the mold matrix 2 and forms the dent precisely, so as to obtain a mold with good transfer rate.



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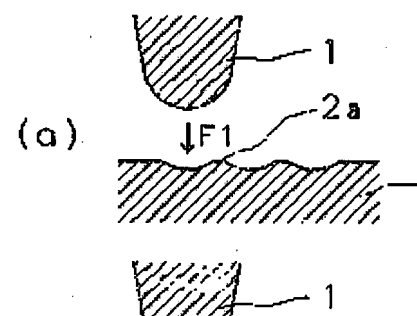
(54) 【発明の名称】 金型の製造方法およびこの金型により製造した光学素子

(57) 【要約】

【課題】 転写率のよい所望の形状の圧痕を成形した金型を得る。

【解決手段】 圧子1を金型母材2の表面に押圧して複数の圧痕を成形するにあたり、同じ位置で圧子1を複数回、金型母材2表面に押圧する。

F1 &lt; F.



(2)

特開平 11-

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## 【特許請求の範囲】

【請求項 1】 圧子を金型母材の表面に押圧して複数の圧痕を成形する金型の製造方法において、前記圧痕を成形する際に同じ位置で前記圧子を数回に渡って前記金型母材表面に押圧することを特徴とする金型の製造方法。

【請求項 2】 請求項 1 に記載の金型の製造方法において、前記圧子の押し込み回数を  $N$  としその時の押し込み力をそれぞれ  $F_1$ 、 $F_2 \cdots F_n$  とする時に  $F_1 < F_2 < \cdots < F_n$

であることを特徴とする金型の製造方法。

【請求項 3】 請求項 1 で製造された金型の圧痕形状を光学部材に転写したことを特徴とする光学素子。

## 【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、金型の製造方法およびこの金型により製造した光学素子に関するものである。

【0002】

【従来の技術】従来、マイクロ光学素子は、単体としては光学通信などに用いられ、多数配列したアレイとしては光学機器の集光板や拡散板などに用いられている。このようなマイクロ光学素子には凸レンズ、凹レンズ、反射鏡などがある。上記マイクロ光学素子を製造する方法としては所望の光学素子の反転形状が表面に形成してある金型を用いて樹脂を射出成形や圧縮成形することにより製造する方法がある。

【0003】そして、金型表面にマイクロ光学素子の反転形状を成形するために、特開平 9-327860 号公報に記載されている圧痕法を用いることができる。この方法を使用する装置は、圧子を保持して金型母材に押圧するムービングコイル装置と XY ステージと制御装置とで構成されている。ムービングコイル装置と XY ステージとは制御装置によって電気的に制御されており、圧子の上下の繰り返しと共に金型母材を水平面内で移動させることによってマイクロ光学素子アレイの反転形状を金型表面に形成する。その際、転写率の良い圧痕を形成するために、圧子の押し込み時間を長くすると、その前に形成された隣り合わせの圧痕形状が崩れてしまい形状精度の良いマイクロ光学素子アレイが得られないという問題があった。すなわち、金型母材上で圧子の押圧を順次

方法において、前記圧痕を成形する際に圧子を数回に渡って前記金型母材表面に、しくは、一つの圧痕を形成するのに複数回、その回数が必要とする圧痕、ひいては光学素子の大きさを考慮して実験的に決めた押し込み力としては回数毎に大きくしていく。1 回目の押し込み力を  $F_1$  とし、すると  $F_1 < F_2 < \cdots < F_n$  とい、このように押し込み力を調整することの形状の圧痕を形成でき、転写率がよく、

【0006】

【発明の実施の形態】以下、本発明の一付図面に基いて説明する。図 1 は、本発明のマイクロ光学素子アレイ製造用金型の製造方法である。また、図 2 は金型母材の表面に成形するための圧子押圧装置の構成を概略図、図 3 は、図 2 の圧子押圧装置の一部のコイル装置の構成を説明するための断面図。

【0007】本実施の形態ではマイクロ

成形用金型の製造に際して、マルテンサス鋼からなる金型母材の表面（キャビティ表面であり、以下「キャビティ面」とい加工を施し、金型母材のキャビティ面を形成する。図 1 にこのような金型母材 2 を示す。押圧力で、圧子 1 をキャビティ面に押圧し、キャビティ面全面に押圧力  $F_1$  で圧痕を成形より大きな押圧力  $F_2$  で既に成形した圧痕に押圧する（b）。ついで、押圧力  $F_2$  より大きな押圧力  $F_3$  で既に成形した圧痕上に圧子 1 を押圧する（c）。このようにして、押圧力を徐々に渡って押圧することにより、金型母材の表面の材料 2 a が横移動することを抑え、圧痕を形成でき、転写率の良い金型を作る。

【0008】次に図 2 に示す圧子押圧装置の構成により、金型母材の表面に多数の圧痕を形成する。図 2 の圧子押圧装置の構成および動作から、マイクロ光学素子アレイ成形用金型への圧痕加工方法を説明する。図 2 に示す機械式の固定方法あるいは接着などの固定方法により、金型母材 2 を保持するための XY ステージ

タ6Xと、XYステージ4のY方向位置を検出するためのデジタルマイクロメータ6Yとが設けられている。デジタルマイクロメータ6Xおよび6Yの出力は、ステージ移動量検知回路21に供給されるように構成されている。

【0010】従って、XYステージ4は、ステージ駆動回路20により制御されるモータ5Xとモータ5Yとの作動により、XY平面において二次元的に移動可能である。また、XYステージ4のXY平面における位置情報、すなわちXYステージ4のX方向移動量およびY方向移動量は、デジタルマイクロメータ6Xおよび6Yの出力に基づいてステージ移動量検出器21で検出される。

【0011】さらに、図2に示す圧子押圧装置は、支持体7に固定されたムービングコイル装置3を備えている。ムービングコイル装置3の断面図を図3に示し、詳述する。ムービングコイル装置3のシャフト11には、先端部分が円錐をした圧子1が取り付けられている。33はシャフト11に外挿するように設けられた円筒状の永久磁石であり、ベース板32に固定されている。35はシャフト11に取り付けられ、永久磁石に外挿するようように設けられたコイル支持棒であり、コイル36が環状に巻き付けてられている。37はコイル14に外挿するよう設けられた環状の永久磁石であり、ベース板34に固定されている。

【0012】30、31は板バネであり、板バネ30の基端は、ベース板32に固定されたブロック38に押さえ板38aとボルトにて固定されている。板バネ30の先端は、シャフト11と一体となっている連結リング39によりシャフト11と連結されている。一方、板バネ31も板バネ30と同様にベース板34に固定、シャフト11に連結されている。したがって、シャフト11は板バネ30、31によって鉛直線を往復移動可能に弾性支持されている。

【0013】永久磁石37は下部がS極、上部がN極に。一方、永久磁石33は下部がN極、上部がS極に着磁されており、シャフト11の中心軸での磁力線の向きは鉛直下方である。ここで、コイル36で発生する磁力線がシャフト11の中心軸で鉛直下向きとなるように匝数を与えると、コイル36に対して鉛直下向きの力が働

子1の押し付け力を変えることができる。  
【0014】従って、図3の圧子押圧装  
ングコイル駆動装置22により、ムービ  
3のシャフト11をひいてはダイヤモンド  
方向に移動させ、XYステージ4上に保  
材2のキャビティ面の所定位置にダイ  
先端部を所定の圧力で押圧することがで  
果、金型母材2のキャビティ面にはダイ  
の先端部に対応した形状を有する圧痕が  
の圧痕形成工程は、成形すべきマイクロ  
を構成するマイクロ光学素子の数と同数  
返される。

【0015】従って、本実施例では、コは、予めプログラミングされた圧痕開始位置4を移動するようにステージ駆動回路21を出力すると共に、1回目のダイヤモンド圧力1.8Vの電圧をムービングコイル22に出力する指令をムービングコイル駆動回路22に出力する。ムービングコイル駆動回路22は、検知回路21の出力と圧痕開始位置とが一致するまでコンピュータ23からの指令に基づき、ダイヤモンドを圧力1.8Vの電圧で金型母材2の打ち付ける。コンピュータ23は、ステージ24によりXYステージ4を二次元的に移動させる。XYステージ4はXYステージ4の位置信号をムービングコイル駆動回路22に出力する。ムービングコイル駆動回路22は、コンピュータ23からの位置指令とXYステージ4の位置信号とが一致する毎にコイル22に1.8Vで、ダイヤモンド圧子1をZ方向に移動させ、金型母材2のキャビティ面を形成する。金型母材のキャビティ面に成形される凹部は、例えば、25mm×35mmの範囲となる。

【0016】このようにして行われた11  
後、XYステージ4が圧痕開始位置へ戻  
る。ピエゾ23はステージ駆動回路20を  
ステージ4を移動する。そして、コンピュ  
タ10の圧痕上に順次2回目の圧痕を成形す  
る。駆動回路20、ムービングコイル駆動回

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した。なお、圧子1の押し込み力Fはムービングコイル装置がムービングコイルに与える電圧に依存しており、 $V1 < V2 < \dots < Vn$ なる電圧V1、V2、 $\dots$  Vnを与えたときの押し込み力F1、F2、 $\dots$  Fnは $F1 < F2 < \dots < Fn$ となる。そして、順次押圧力を強くしていくことが好ましいが、本発明は、必ずしもこれに限られない。

【0017】本実施の形態では、上述の工程に従って製造されたマイクロ光学素子アレイ成形用金型とアクリル樹脂を用いて射出成形することにより、マイクロ光学素子として凸レンズを多数配置したマイクロレンズアレイを製造した。なお、本発明に係る製造方法では圧子の押圧手段として、前記ムービングコイル装置に限定されるものではなく、ピエゾ素子などを用いてもよい。また、上記実施の形態では、第1の押し込み力で圧痕を打った後、他の押し込み力でさらに圧痕を打ったが、1つの圧痕を押し込み力を変えて打った後、次の圧痕を打つようにしても良い。

【0018】さらに上記実施の形態では、マイクロレンズアレイを製造する例を上げたが、圧痕を成形する金型一般に適用できる。

【0019】

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【発明の効果】以上のように本発明によれば、隣り合わせの圧痕形状が崩れず、形状の良い圧痕を成形した金型を容易かつ迅速に製造できる。また、このように成形された金型を用いることによって、転写率の良い光学素子を得ることができる。

【図面の簡単な説明】

【図1】本発明によるマイクロ光学素子アレイの製造を説明する図である。

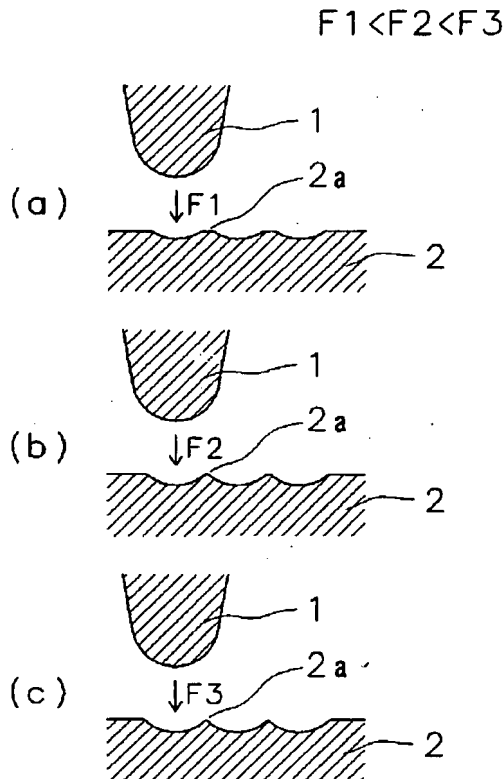
【図2】圧子押圧装置の概略を示す斜視図である。

【図3】ムービングコイル装置3の詳細を示す断面図である。

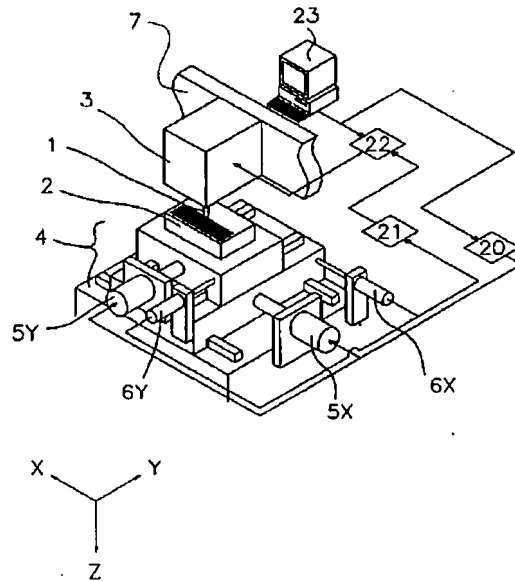
【符号の説明】

- 1 圧子
- 2 金型母材
- 3 ムービングコイル装置
- 4 XYステージ
- 5 ステージ駆動回路
- 6 ステージ移動量検知回路
- 7 ムービングコイル駆動回路
- 8 コンピュータ
- 36 コイル

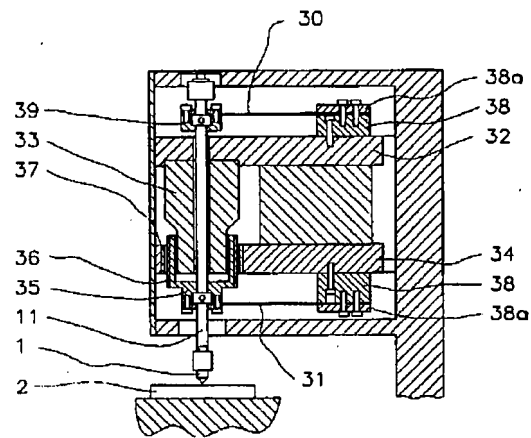
【図1】



【図2】



【図3】



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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the optical element manufactured with the manufacture approach of metal mold, and this metal mold.

[0002]

[Description of the Prior Art] Conventionally, a micro optical element is used for an optical communication link as a simple substance, and is used for a condensing plate, a diffusion plate, etc. of an optical instrument as an array which carried out the a large number array. There are a convex lens, a concave lens, a reflecting mirror, etc. in such a micro optical element. There is a method of manufacturing resin injection molding and by pressing using the metal mold with which the reversal configuration of the optical element of the request as an approach which manufactures the above-mentioned micro optical element is formed in the front face.

[0003] And in order to fabricate the reversal configuration of a micro optical element on a metal mold front face, the indentation method indicated by the publication-number No. 327860 [ nine to ] official report can be used. The equipment which uses this approach consists of the moving coil equipment, X-Y stages, and control units which hold an indenter and are pressed to a metal mold base material. Moving coil equipment and an X-Y stage are electrically controlled by the control unit, and form the reversal configuration of a micro optical element array in a metal mold front face by moving a metal mold base material in the level surface with the repeat of the upper and lower sides of an indenter. In order to form an indentation with the sufficient rate of an imprint in that case, when pushing time amount of an indenter was lengthened, the indentation configuration next to each other formed before that collapsed, and there was a problem that a micro optical element array with a sufficient configuration precision was not obtained. That is, if press of an indenter is advanced one by one on the metal mold base material, it deforms by horizontal migration of the ingredient of the boundary of the metal mold base material by press of an indenter at the time of formation of the following concave surface configuration where the formed concave surface configuration adjoins, and a desired configuration cannot be acquired at it.

[0004]

[The technical problem which invention considers as a solution activity] Then, this invention aims at offering the optical element fabricated using this metal mold to the manufacture approach of the metal mold which forms the indentation of a desired configuration.

[0005]

[Means for Solving the Problem] In this invention, in the manufacture approach of the metal mold which presses an indenter on the front face of a metal mold base material, and fabricates two or more indentations, in case said indentation is fabricated, said indenter is pressed on said metal mold base material front face over several times in the same location. The count which stuffs the count indenter of plurality into forming one indentation preferably is experimentally decided in consideration of the magnitude of the indentation to need, as a result the optical element to need. It is good to enlarge for every count as pushing force of an indenter. namely, -- if the 1st pushing force is set to F1 and the n-th

time is set to  $F_n \rightarrow F_1 \rightarrow \dots \rightarrow F_2 \rightarrow \dots$ . Relation called  $<F_n$  is good. Thus, by adjusting the pushing force, the indentation of a desired configuration can be formed and the rate of an imprint becomes good. [0006]

[Embodiment of the Invention] Hereafter, the gestalt of 1 operation of this invention is explained based on an accompanying drawing. micro optical element array manufacture according [ drawing 1 ] to this invention -- public funds -- it is drawing explaining the production process of a mold. Moreover, the perspective view showing roughly the configuration of indenter press equipment for drawing 2 to form many indentations in the front face of a metal mold base material and drawing 3 are the sectional views for explaining the configuration of the moving coil equipment which is some indenter press equipments of drawing 2.

[0007] With the gestalt of this operation, on the occasion of manufacture of a micro optical element array molding die, metal polish processing is performed to the front face (henceforth [ it is the front face which should turn into a cavity side, and ] a "cavity side") of the metal mold base material which consists of martensitic stainless steel, and the cavity side of a metal mold base material is formed in the shape of a mirror plane. Such a metal mold base material 2 is shown in drawing 1. First, an indenter 1 is pressed to a cavity side by the thrust of  $F_1$  (a). After fabricating an indentation by thrust  $F_1$  all over a cavity side, an indenter 1 is pressed on the indentation already fabricated by the bigger thrust  $F_2$  than  $F_1$  (b). Subsequently, an indenter 1 is pressed on the indentation already fabricated by the still bigger force  $F_3$  than thrust  $F_2$  (c). Thus, by increasing thrust gradually and pressing over several times, it can suppress that ingredient 2a of the boundary of an indentation where the metal mold base material 2 adjoins carries out horizontal migration, an indentation can be formed with a sufficient precision, and metal mold with the sufficient rate of an imprint can be made.

[0008] Next, many indentations are formed in the front face of a metal mold base material by the indentation method using the indenter press equipment shown in drawing 2. Hereafter, the indentation processing approach to the cavity side of a micro optical element array molding die is explained, referring to the configuration and actuation of drawing 2 of indenter press equipment. The press equipment shown in drawing 2 is equipped with X-Y stage 4 for holding the metal mold base material 2 by the fixed approaches, such as the fixed approach of a mechanical cable type, or adhesion. The cavity side of the metal mold base material 2 with which metal polish processing was already performed on this X-Y stage 4 is held at a level with XY flat surface. Motor 5X for driving X-Y stage 4 in the direction of X and motor 5Y for driving X-Y stage 4 in the direction of Y are prepared in X-Y stage 4. Motor 5X and motor 5Y is constituted so that it may be controlled by the stage actuation circuit 20 based on the command from a computer 20.

[0009] Moreover, digital micrometer 6X for detecting the direction location of X of X-Y stage 4 and digital micrometer 6Y for detecting the direction location of Y of X-Y stage 4 are prepared in X-Y stage 4. The output of the digital micrometers 6X and 6Y is constituted so that the stage movement magnitude detecting circuit 21 may be supplied.

[0010] Therefore, X-Y stage 4 is movable two-dimensional in XY flat surface by actuation with motor 5X and motor 5Y which are controlled by the stage actuation circuit 20. Moreover, the amount of X directional movements and the amount of Y directional movements of the positional information 4 in XY flat surface of X-Y stage 4, i.e., an X-Y stage, are detected by the stage movement magnitude detector 21 based on the output of the digital micrometers 6X and 6Y.

[0011] Furthermore, the indenter press equipment shown in drawing 2 is equipped with the MUBINGUKOI equipment 3 fixed to the base material 7. The sectional view of moving coil equipment 3 is shown and explained in full detail to drawing 3. The indenter 1 to which the amount of point carried out the cone is attached in the shaft 11 of moving coil equipment 3. 33 is the permanent magnet of the shape of a cylinder established so that it might extrapolate at a shaft 11, and is being fixed to the base plate 32. 35 is attached in a shaft 11, and as extrapolated to a permanent magnet, it is the coil housing prepared like, and the coil 36 twisted it annularly and it shines. 37 is the annular permanent magnet prepared so that it might extrapolate in a coil 14, and is being fixed to the base plate 34.

[0012] 30 and 31 are flat springs and the end face of a flat spring 30 is being fixed to the block 38 fixed

to the base plate 32 with presser-foot plate 38a and a bolt. The head of a flat spring 30 is connected with the shaft 11 with the connection ring 39 which is united with the shaft 11. On the other hand, it connects with the base plate 34 like [ a flat spring 31 ] the flat spring 30 at immobilization and a shaft 11. therefore, the shaft 11 -- flat springs 30 and 31 -- a vertical line top -- a round trip -- elastic support is carried out movable.

[0013] a permanent magnet 37 -- the lower part -- on the other hand, as for a permanent magnet 33, the lower part is magnetized by N pole, N pole and the upper part are magnetized for the south pole and the upper part by the south pole, and the sense of the line of magnetic force in the medial axis of a shaft 11 is a vertical lower part. Here, if a current is given so that the line of magnetic force generated with a coil 36 may serve as vertical facing down by the medial axis of a shaft 11, the force of vertical facing down will work to a coil 36, and a shaft 11 will move to a vertical lower part. On the other hand, if the current of the reverse sense is given to a coil 36, the force of the vertical upper part will work and a shaft 11 will move to the vertical upper part. The moving coil actuation circuit 22 has the adjustable pulse current generator, and can move an indenter 1 up and down at high speed by outputting the current of the shape of a pulse shape from which a polarity changes periodically to a coil 36. Besides, the period of downward moving can be set to 0.1-50Hz. In addition, an up-and-down stroke is about 50 micrometers. Moreover, the pressure of the indenter 1 to the cavity side of the metal mold base material 2 is changeable by changing the magnitude of the current supplied to a coil 36.

[0014] Therefore, in the indenter press equipment of drawing 3, with the moving coil driving gear 22, if the shaft 11 of moving coil equipment 3 is pulled, the diamond indenter 1 can be moved to + Z direction, and the point of the diamond indenter 1 can be pressed by the predetermined pressure in the predetermined location of the cavity side of the metal mold base material 2 held on X-Y stage 4. Consequently, the indentation which has a configuration corresponding to the point of the diamond indenter 1 is formed in the cavity side of the metal mold base material 2. This indentation formation process covers the number and same number time of a micro optical element which constitute the micro optical element array which should be fabricated, and is repeated.

[0015] Therefore, in this example, a computer 23 outputs the command whose moving coil actuation circuit 22 outputs the electrical potential difference of thrust 1.8V of the 1st diamond indenter 1 to the moving coil actuation circuit 22 while outputting a command signal to the stage actuation circuit 22 so that X-Y stage 4 may be moved to the indentation starting position programmed beforehand. If the output and indentation starting position of the moving coil actuation circuit 22 of the stage location detecting circuit 21 correspond, it will strike the diamond indenter 1 against the cavity side of the metal mold base material 2 on the electrical potential difference of thrust 1.8V based on the command from a computer 23. A computer 23 moves X-Y stage 4 two-dimensional by the stage actuation circuit 20. The stage movement magnitude detecting circuit 21 inputs the signal according to the location of X-Y stage 4 into the moving coil actuation circuit 22. Whenever the position signal of the moving coil actuation circuit 22 of X-Y stage 4 from the location command from a computer 23 and the stage movement magnitude detecting circuit 21 corresponds, it is driver voltage 1.8V of a coil 36, carries out both-way migration of the diamond indenter 1 periodically to a Z direction, and fabricates an indentation one by one to the cavity side of the metal mold base material 2. The number of the indentations fabricated by the cavity side of a metal mold base material becomes about 2,200,000 pieces in the range of 25mmx35mm.

[0016] Thus, a computer 23 moves X-Y stage 4 through the stage actuation circuit 20 so that X-Y stage 4 may return to an indentation starting position after the 1st performed processing termination. And a computer 23 controls the stage actuation circuit 20 and the moving coil actuation circuit 22 to fabricate the 2nd indentation one by one on the 1st indentation. The driver voltage of the diamond indenter 1 which a computer 23 orders it to the moving coil actuation circuit 22 at the time of the 2nd indentation shaping is 2.4V. And indentation processing of the count of said is performed to the 1st homotype enclosure. After the 2nd indentation shaping finishes, the 3rd electrical potential difference of thrust 3.2V is impressed to a coil 36 for X-Y stage 4 from return and the moving coil actuation circuit 22 to the same indentation starting position as the 1st time (the same is said of the 2nd time), and indentation

processing of the count of said is performed to the 1st time and the 2nd homotype enclosure. Three indentation processings were performed to the range of 25mmx35mm of the cavity side of the metal mold base material 2, and the indentation with the sufficient rate of an imprint was formed. in addition, the electrical potential difference to which moving coil equipment gives the pushing force  $F$  of an indenter 1 to a moving coil -- depending -- \*\*\*\* --  $V_1$  -- < --  $V_2$  -- < -- ... <  $V_n$  -- electrical potential differences  $V_1$  and  $V_2$  and ... the pushing force  $F_1$  and  $F_2$  when giving  $V_n$ , and ...  $F_n$  --  $F_1$  -- < --  $F_2$  -- < ... It is set to <  $F_n$ . And although it is desirable to strengthen thrust one by one, this invention is not necessarily restricted to this.

[0017] With the gestalt of this operation, the micro-lens array which has arranged many convex lenses as a micro optical element was manufactured by injection molding using the micro optical element array molding die and acrylic resin which were manufactured according to the above-mentioned process. In addition, by the manufacture approach concerning this invention, not the thing limited to said moving coil equipment but a piezo-electric element etc. may be used as a press means of an indenter. Moreover, one indentation is pushed in, and after the gestalt of the above-mentioned implementation changes and strikes the force, you may make it strike the following indentation, although other pushing force struck the indentation further after the 1st pushing force struck the indentation.

[0018] Although the example which manufactures a micro-lens array was furthermore raised with the gestalt of the above-mentioned implementation, it is applicable to the general metal mold which fabricates an indentation.

[0019]

[Effect of the Invention] As mentioned above, according to this invention, an indentation configuration next to each other does not collapse, but the metal mold which fabricated the indentation with a sufficient configuration can be manufactured easily and promptly. Moreover, an optical element with the sufficient rate of an imprint can be obtained by using the metal mold fabricated in this way.

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[Translation done.]

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2. \*\*\*\* shows the word which can not be translated.
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EFFECT OF THE INVENTION

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[Effect of the Invention] As mentioned above, according to this invention, an indentation configuration next to each other does not collapse, but the metal mold which fabricated the indentation with a sufficient configuration can be manufactured easily and promptly. Moreover, an optical element with the sufficient rate of an imprint can be obtained by using the metal mold fabricated in this way.

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[Translation done.]